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ABSTRACT

In January 1986, the Virginia State Board for Community Colleges and the State Council of Higher Education undertook a joint study of postsecondary remedial education. The purposes of the study were to: (1) define the minimum levels of competence required of a student wishing to do college-level work for degree credit; (2) develop methods and criteria for assessing how much students are learning in remedial programs and how successful they are in degree credit work after remediation is complete; and (3) propose procedures by which even more of the remedial work done in the Virginia system of higher education can be undertaken by the community colleges. The study report is divided into sections addressing these three purposes. Section 1 considers minimum competency levels in terms of mandatory student assessment; establishes minimum levels of competence in writing, reading, mathematics; and discusses levels of instruction, options for assessment procedures, enrollment in remedial and other courses, enrollment limits, and class size. Section 2 offers recommendations for assessing the effectiveness of remediation in terms of student learning and student success in degree-credit work. Section 3 proposes procedures whereby the community college system can take on more of the remedial work provided in Virginia higher education. (EJV)

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REPORT OF THE
STATE COUNCIL OF HIGHER EDUCATION/
VIRGINIA COMMUNITY COLLEGE SYSTEM
JOINT TASK FORCE ON REMEDIATION

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Presented to

the State Council of Higher Education
for Virginia

and

the State Board for Community Colleges

January 6, 1988

JC 880061

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REPORT OF THE
JOINT TASK FORCE ON REMEDIAL EDUCATION

Executive Summary

At their joint meeting in January 1986, the State Board for Community Colleges and the State Council of Higher Education directed their respective staffs to undertake a joint study of remedial education. The purposes of the study are

1. to define the minimum levels of competence required of a student wishing to do college-level work for degree credit;
2. to develop methods and criteria for assessing how much students are learning in remedial programs and how successful they are in degree credit work after remediation is complete; and
3. to propose procedures by which even more of the remedial work done in the Virginia system of higher education can be undertaken by the community colleges.

Membership on the task force included persons from the seven senior colleges and universities that currently offer remedial coursework and representatives from 11 two-year colleges. Between March and November, 1987, the task force met often as a full group and in subcommittees. The work of the task force builds upon a previous State Council report, An Assessment of Remedial Education Programs in Virginia (1983).

The report of the Task Force is divided into three sections which address the three purposes of the study. Within each section, specific

recommendations are made about what students ought to know to do college-level work, and when. For this reason, the whole of the report is a series of recommendations made to the persons responsible for remedial education in the Commonwealth's two-year and four-year state-supported colleges and universities.

At the joint meeting of the State Council of Higher Education and the State Board for Community Colleges, the two boards will review the study. The boards are expected to act independently at subsequent meetings to approve the report.

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REPORT OF THE
JOINT TASK FORCE ON REMEDIAL EDUCATION

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The task force makes the following recommendations on remedial education[1] in response to the three study objectives.

OBJECTIVE #1: to define the minimum levels of competence of a student wishing to do college-level work for degree credit.

This section defines minimum levels of competence in writing, reading, and mathematics needed by a student wishing to do college-level work for degree credit[2] in the Commonwealth. In addition, it describes the conditions under which these competencies can best be implemented. By implication, it is understood that each institution of public higher education should establish entry-level competencies at or above these levels, depending upon institutional mission and the nature of individual degree programs. It is further understood that, as colleges require these competencies for college-level work, they should work closely with feeder high schools to ensure that their graduates are prepared to begin college-level work upon admission to college.

A. Required Assessment

Guideline 5 of the Council's Guidelines for Student Assessment requires that all institutions "identify minimum verbal and quantitative skills below which threshold students will need remediation at that institution." Diagnostic assessment or placement testing of students identified by the institution as likely to be deficient in those skills must be mandatory in writing, reading, and mathematics (Recommendation #V from the 1983 State Council Task Force Report, An Assessment of Remedial Education Programs in Virginia). The timing of this assessment will be based upon the mission of the institution and its student population. However, such assessment must take place for all students no later than

(a) enrolling in or planning to enroll in a college-level course in mathematics or English composition or communications that will be required for a degree,

(b) admission to any degree program, or

(c) accumulating nine semester hours of college credit at this or another institution.

B. Competencies

"Minimum levels of competence" were determined by a process that generated descriptions of competencies and skills needed to enroll and succeed in college-level courses. Several other approaches (e.g., statewide tests with statewide minimum cut-off scores; a variety of tests with statewide cut-off scores) were considered, but it was agreed that the descriptive approach was preferable. Several national and state-level groups have already produced documents that define college-level competencies in reading, English composition, and mathematics.[3] These documents were used as a starting point for the task force as it developed the following descriptions of minimum competencies in writing, reading, and mathematics.

Writing

An entry-level college student in a degree-credit English course should demonstrate the following writing skills in a writing sample or other measure of writing ability:

Organization and Development

a. The writer's purpose (thesis) is the primary controlling force throughout the essay or other piece of writing.

b. The thesis is adequately developed with generalizations supported by some specific explanations, examples, and evidence.

c. The organizational pattern is evident, although there may be occasional digressions.

Word Choice

a. Words are used appropriately in context.

b. The choice of words is precise--not vague or contrived.

c. The words used are appropriate to the audience and topic.

Syntax

a. Sentence structures do not interfere with a smooth flow of information; the reader has little need to backtrack or guess at the writer's intent.

b. The student demonstrates a capacity to produce syntactic variety and complexity.

c. There are few comma splices, run-on sentences, and fragments.

Mechanics

a. There are few errors of spelling, punctuation, and capitalization.

b. There are few errors of inflection and agreement, particularly subject-verb and pronoun-antecedent agreement.

Reading [4]

Following are the kinds of skills and competencies generally assessed in measuring student reading levels:

A. The ability to recognize and recall material at a literal level and be able to summarize it.

B. The ability to interpret a writer's meaning inferentially as well as literally.

C. The ability to evaluate critically and make judgements of textual material and to recognize different purposes and methods of writing.

D. The ability to vary one's reading speed and methods according to the purpose and type of material.

E. The possession of a vocabulary sufficient to support further development of the above reading competencies.

Levels of Instruction

I. Pre-developmental

A pre-developmental student possesses less than a 6th-grade level of mastery in the prescribed reading competencies as measured by any valid qualitative or quantitative assessment instrument. Community colleges and those senior institutions with special populations or missions may provide pre-remedial instruction to students reading below grade level 6. Such instruction should become part of the institutional mission of the community colleges and be offered if and only if the college is provided resources and staff adequate to provide this level of instruction. Students assessed as reading below grade level 6 must take pre-remedial reading, then remedial-level instruction, as a pre-requisite to enrollment in any college-level courses, except those courses specifically identified and exempted from this requirement by their college.

II. Pre-requisite developmental

A pre-requisite developmental student possesses skills at a 6th- to 9th-grade level of mastery in the prescribed reading competencies as measured by any valid qualitative or quantitative assessment instrument. Students assessed as reading at grade levels 6-9 must take remedial/developmental reading as a pre-requisite to enrollment in any college-level courses, except those courses specifically identified and exempted from this requirement by their college.

III. Co-requisite developmental

A co-requisite developmental student possesses skills at a 10th- to 12th-grade level of mastery in the prescribed reading competencies as measured by any valid qualitative or quantitative assessment instrument. Students assessed as reading at grade levels 10-12 should enroll in remedial/developmental reading as a co-requisite for enrollment in college-level courses.

IV. Unrestricted

Unrestricted students should possess mastery in the prescribed reading competencies above the 12th grade-level as measured by any qualitative or quantitative assessment instrument. Students assessed as reading above grade level 12 should have unrestricted enrollment in college-level courses, except for enrollment in programs with specific entrance requirements.

Mathematics

Students enrolled in programs leading to the associate in arts (AA), the associate in science (AS), the associate in arts and sciences (AA&S), and the baccalaureate degree should possess the following competencies:[5]

In Algebra

- Familiarity with the properties of and skill in operations with the real number system.

- Ability to simplify algebraic expressions involving radicals and exponents.
- Ability to perform operations on polynomials and rational expressions.
- Ability to solve linear, quadratic, and rational equations and inequalities.
- Ability to solve systems of linear equations.
- Ability to graph linear and quadratic equations.
- Ability to derive linear equations, given sufficient information.
- Familiarity with functions and their notation.
- Ability to apply algebraic notation and concepts in solving applied (word) problems.

In Geometry

- Familiarity with the basic terminology and notation of geometry.
- Familiarity with the concepts of similarity, congruency, symmetry, and equality.
- Ability to determine relevant relations among the angles formed by perpendicular and parallel lines.
- Familiarity with the properties of plane and solid figures and their names.
- Ability to solve problems associated with triangles, including the use of the Pythagorean theorem and special right-triangle relationships.
- Ability to apply formulas for perimeters, areas, volumes, and surface areas of geometric figures.

Students enrolled in programs leading to the associate in applied science (AAS) degree should at a minimum possess the following competencies:[6]

In Arithmetic and Geometry

- Ability to perform the computations of addition, subtraction, multiplication, and division using whole numbers, fractions, and decimals.
- Familiarity with the meaning of fractions, decimals, and percent and their relationships to one another.
- Ability to use percents to solve simple percentage problems.
- Ability to use and interpret graphs and tables.
- Familiarity with the concepts and notation of roots and powers.
- Ability to classify geometric figures and their parts.
- Ability to apply formulas for perimeters and areas of simple geometric figures.
- Ability to make and use measurements in both English and metric units.

In Basic Algebra

- Ability to formulate, evaluate, and simplify algebraic expressions.
- Ability to translate practical verbal problems into appropriate algebraic equations and inequalities.
- Ability to perform computations with integers.
- Ability to solve linear equations.
- Familiarity with the use of ratios, proportions, and formulae.
- Ability to add and subtract simple polynomials.

- Ability to use the distributive property in both multiplying and factoring.

- Ability to solve practical problems dealing with everyday situations that require the above competencies.

C. Choosing Assessment Procedures

Institutions should choose the assessment procedures that are believed to be appropriate for their students, providing that students' attainment of the statewide descriptions of competencies may be measured. Assessment procedures may include analysis of a student's high-school or college transcript, SAT scores, or results of diagnostic testing and placement tests, either locally developed or commercially available. One reason for the extreme variation in placement tests found to be used by colleges today[7] is that most colleges are not satisfied with the quality of existing instruments. Therefore, an investigation of the availability of valid, reliable, and diagnostically-oriented assessment instruments needs to be undertaken by the VCCS, which will make that information generally available. Some good instruments may be commercially available; others may need to be developed.

D. Assessment for Special Populations

In designing ways to assess students' skill levels, institutions should be sensitive to the problems faced by minorities and disadvantaged students (Recommendation #VI). Additional or alternative assessment

instruments may need to be developed if equity and fairness are to be served (Recommendation #VI).

E. Enrollment in Remedial and Other Courses

Students assessed as needing remedial education must be required to take and complete successfully remedial courses before taking any course for which they are a prerequisite. This policy would require institutions to identify courses for which basic skills in English grammar and composition, reading, and mathematics are needed. Institutions may wish to identify some courses in which the content does not require sequential learning, thus permitting simultaneous enrollment in remedial education and college work, in order to give students an intensive learning experience while concurrently taking steps to remediate deficiencies. Full participation in degree programs should be limited to students who have demonstrated competency in the basic skills needed for college-level work (Recommendation #VIII).

F. Limit on Enrollments

Normally a student should be limited to two enrollments in the same remedial course. In certain circumstances, a student may be allowed to enroll a third time.

G. Class Size

Institutions should maintain reasonable enrollments in sections of remedial courses, consonant with the SCHEV funding guidelines.

Other Concerns

If these recommendations are to be implemented fully, state and college officials must address a number of issues: the adequate training of faculty to provide coursework at the remedial level and any costs that might be involved in providing this training, the possibility that increased testing will be required during the summer for certain students, the costs of purchasing assessment instruments and of establishing reading/writing/mathematics learning laboratories, and the importance of encouraging interaction between institutions. New and currently available sources of funding should be explored. Although college-degree credit must not be given for remedial work, administrative credit may be granted to students requiring remediation who need to maintain financial aid eligibility.

OBJECTIVE #2: to develop methods and criteria for assessing how much students are learning in remedial programs and how successful they are in degree credit work after remediation is complete.

In order to address Objective 2, a survey was sent to all colleges and universities requesting information on what assessment instruments and tracking systems are being used. Thirty-five responses were returned; seven responses were from four-year colleges and 28 responses were from two-year colleges. The results of this survey are shown in Appendix A.

A. Assessing Student Learning in Remedial Programs

In general, the surveys contained a range of responses similar to that reported in previous studies. In the opinion of the task force, the survey data did not clearly reveal adequate assessment models for quantitatively determining what a student learns in a remedial course. In light of these responses and the charge to the task force in Objective 2, it is recommended that

1. The educational objectives of each remedial course be stated clearly by each institution.
2. Insofar as possible, the objectives be measurable without making the learning trivial.
3. A pre-test which measures performance related to the objectives be given for each remedial course.
4. A similar post-test to determine the amount of growth and/or changed behavior be administered.

5. The curriculum and pre- and post-tests be designed so that the results of testing programs can be used to improve the curriculum.
6. Clear exit criteria be established for remedial courses.

These recommendations are consistent with Guidelines 5 and 6 of the Guidelines for Student Assessment and should be developed as part of every institution's student assessment plan.

B. Determining Success in Degree-Credit Work

Of the 31 survey responses analyzed in response to how institutions track the success of former remedial students, six reported no system for evaluating student progress. Of those institutions reporting some form of tracking, the most common measures included:

- student grade-point average
- course-grade performance in freshman courses in English and mathematics
- retention rates for remedial students
- student performance in selected courses, in addition to English and mathematics, often tracked through a computerized database.

Many institutions have attempted to develop tracking systems but have not been successful in developing meaningful, comprehensive systems. They currently are reexamining their tracking systems in light of Guideline 4 of Guidelines for Student Assessment, which calls for "plans and means of measuring the success of remediation." Therefore, the task force recommends

that the Commonwealth provide management assistance to institutions to develop or expand tracking systems. This guidance could take the form of consulting services to evaluate plans, information-sharing among institutions, support for offices of institutional research in order to create an efficient data system, and similar activities.

In fact, the Virginia Community College System is working toward a Research and Assessment Data Support System (to be called RADSS) that will be designed to undergird longitudinal student tracking and assessment studies.

The RADSS system will be designed to maintain two VSAM data bases: 1) the Student Characteristics History (SCH), and 2) the Student Grade History (SGH). Data contained in the SCH data base are the students' Global Personal Record Data, and the data in the SGH data base comprise the students' academic records.

Having this longitudinal data system will allow VCCS central staff and college staff to produce baseline data for studies on the progress of first-time, full-time students who received high-school diplomas during the prior year and to produce data needed to follow the progress of graduates and/or former VCCS students who have transferred to Virginia's public four-year institutions.

The tracking system at one senior institution, Old Dominion University, was identified as a good example of one that obtains information for program evaluation by a systematic approach to tracking former remedial students.

Each year, the staff of ODU's developmental programs obtains a printout of students who enrolled in English 110 and matches it against rosters of former students of remedial writing courses. Similarly, rosters of students in College Algebra are compared with lists of former students of remedial mathematics. Analyses are conducted to determine which former remedial students completed the entry-level courses and with what grade, and which students withdrew or were withdrawn with a failing grade. These results for remedial students are then compared to the outcomes for all students who were enrolled in the entry-level course. In addition to these annual studies, ODU periodically has conducted long-term studies of retention and graduation rates of former remedial students and of how well these students do on the writing proficiency exam required of all graduates. All of this information is used to analyze the strengths and weaknesses of the developmental program and to make adjustments in the curriculum.

OBJECTIVE #3: to propose procedures by which even more of the remedial work done in the Virginia system of higher education can be undertaken by the community colleges.

Ideally, remedial instruction in higher education would be unnecessary. Students would all have obtained, by the time they graduated from high school, the skills and knowledge necessary to do college-degree credit work. In reality, as many as a half of the students entering college today need some remedial coursework.[8] In an orderly world, it would be possible to have all remediation done at the community colleges. Indeed, where it is feasible or wise, the task force recommends that remedial work be done at the community colleges and that four-year institutions work with neighboring 2-year institutions to provide such instruction to those of their students who need it. An example of such cooperation is provided by George Mason University and Northern Virginia Community College. Although George Mason admits few students it considers unprepared to do college-level work, a small number requires remediation. George Mason contracts with Northern Virginia Community College (NVCC) to offer courses in remedial writing and mathematics on the GMU campus taught by Northern Virginia Community College faculty members. This arrangement, now in its third year, serves only a small number of students, largely those admitted as Summer Transition Program students.

NVCC and GMU also have an articulation agreement whereby GMU encourages students who are unqualified for admission to attend NVCC to make up certain deficiencies. If they enroll in NVCC and meet certain conditions (e.g. complete 30+ credit hours with a 3.0 GPA), they are guaranteed admission to George Mason University.

There are good reasons, however, for some four-year institutions to offer remedial instruction. The mission of Virginia's open-access colleges and universities requires acceptance of underprepared students, to whom remedial instruction is then offered to ensure student success in college-credit work. Institutions should have control over that instruction if they are to be held accountable for the coherence of their curricula.

Institutional control also is necessary if colleges and universities are to be held accountable for the results of remediation, both remediated students' subsequent success and the success of programs that build upon that work. In fact students who take remedial coursework at four-year institutions in the south are slightly more apt than students in two-year colleges to pass those courses and do about as well in subsequent coursework.[9] At some institutions, the very survival of programs like physics, biology, computer science, math, English, or foreign languages depends upon adequate and appropriate remediation being conveniently available to entering students.

Even the most selective institutions in the Commonwealth, in their attempt to ensure access and diversity in their student bodies, will admit some students who are at a disadvantage on traditional academic measures: for instance poor, rural, or minority students. These students need remedial work to help them succeed within a particularly rigorous academic environment. Many are not generally underprepared but have a weakness in mathematics or English that needs to be corrected. The selective institutions are reluctant to discourage these students from attending by diverting them to a local two-year college first.

Finally, often it is not practical for four-year institutions to expect the local two-year college to provide remediation for their students. For example, the distance between the two campuses might entail significant transportation costs. In the meantime, the reduction in enrollments that would result of all remedial activity were moved to two-year colleges could, in several institutions in Virginia, result in the underutilization of space and significant enrollment declines.

Apart from the recognition that some remedial education is necessary at four-year institutions, as outlined above, it is clear that by far the major portion of remedial or developmental education in the Commonwealth remains primarily the responsibility of two-year colleges. Therefore, the task force recommends that as much of this work as is feasible be done by that segment of the higher education community.

FOOTNOTES

[1] For purposes of this study, the definitions of "remedial" and "developmental" education will be those recommended by the 1983 Task Force on Remedial Education. Specifically, remedial education is defined as coursework offered at colleges and universities but having the content and level of work required by high-school students. Developmental education is defined as advising, counseling, and other support services designed to increase the likelihood that students will succeed in college.

Using these definitions is somewhat problematic, however, since few Virginia colleges and universities describe their programs as "remedial." Therefore, use of the term "remedial" is intended to cover what most colleges and universities refer to as "developmental" education or programs. Where the term "developmental" appears in this report, it is used to refer to a particular program at a college or university or to coin a new use of the term (see section on reading competencies).

[2] College-level courses are defined as courses at the 100 level and above given for college-degree credit.

[3] Minnesota Higher Education Coordinating Board, Defining College-Level Skills: Task Force Report, 1986; The College Board, Academic Preparation for College: What Students Need to Know and Be Able to Do, New York, 1983; the New Jersey College Basic Skills Placement Test; and The Academic Senates of the California Community Colleges, The California State University, and The University of California, Statement on Competencies in English and Mathematics Expected of Entering Freshmen, November 1982.

[4] This section lists four levels of instruction and five statements of reading competencies. We delineated the levels of instruction by grade levels because that is the reporting device used most frequently by assessment instruments. We delineated the five competency statements by each of the four levels of instruction, recognizing that these competencies are common to all levels of reading and differ only in degree of sophistication, facility, and mastery. For further explanation of the sub-sets of skills included in these general "descriptions of competencies," see the most current edition of the Standards of Learning Objectives for Virginia Public Schools. This document describes skills at K-12 grade levels.

The task of the reading sub-group was one of balancing differing views, differing levels, differing tools, differing expectations, and differing institutional missions. Quantitative measures are clean and systematic, but qualitative measures--well articulated within individual institutions--are just as valid and can address institutional differences. In summary, this section is an attempt to provide these balances.

[5] These competencies were arrived at through examination and discussion of the Standards of Learning Objectives for Algebra I, Algebra II, and Geometry, the required courses for a 22-credit diploma in Virginia (see Appendix B).

[6] These competencies are based on the State Adopted Competencies for Mathematics, largely reflected in the Standards of Learning Objectives for General Mathematics 9, and the Standards of Learning Objectives for Introduction to Algebraic Concepts, "a course designed for the student who has successfully completed General Mathematics 9 and whose educational plan does not include the study of an academic mathematics program" (see Appendix C). In general, this would apply to students pursuing the standard high school diploma.

[7] Results from the Survey of Practices for Assessing/Evaluating Students in Developmental/Remedial Education, VCCS, Spring 1987; and A Report on College-Level Remedial/Developmental Programs in SREB States, Southern Regional Education Board, 1987.

[8] Report on College-Level Remedial/Developmental Programs in SREB States 1987, p. 1.

[9] Report on College-Level Remedial/Developmental Programs in SREB States, 1987, pp. 52 & 60.

APPENDICES

APPENDIX A

Remediation Task Force
Objective 2
Placement Methods Survey Results - Question 1.

What measures or methods, including specific tests, are used to assess students for appropriate placement, to which students are these tests or other methods administered, and at what point are these measurements/assessments given?

I. Reading

Test Used	Number of campuses using the test
A. Nelson-Denny	8
B. McGraw-Hill	4
C. McGraw-Hill & SAT	1
D. C.G.P.	6
E. IRA/Nelson-Denny	1
F. Reading for understanding	1
G. EQE/SRA/SAM	1
H. MP	1
I. Stanford	1
J. Michigan	1
K. Assessment & Placement Services for Community Colleges Test	2
L. Pulse & McGraw-Hill	1
M. English Placement Test	1
N. CGP & Nelson-Denny	1
O. DRP	1

II. Writing

A. T.S.W.E. and Sample	2
B. SAT/In-House	2
C. EQE	3
D. T.S.W.E.	1
E. CGP	8
F. SAT and Sample EGQ and In-House	1
G. In-House and Descriptive Test of Language Skills Usage	1
H. EQE and Sample	6
I. CGP and Sample	1
J. EQE/SRA/Sample	1
K. ETS and Sample	1
L. Essentials of English	1
M. Assessment/Placement Services for Community Colleges Test	3
N. English Placement Test	1
O. Recognition of Patterns/Sample/ Better Spelling	1

Remediation Task Force
Objective 2
Placement Methods Survey Results - Question 1.

III. Mathematics

Test Used	Number of campuses using the test
A. In-House	18
B. SAT	1
C. CGP	4
D. Descriptive Tests of Math/College Board	4
E. College Board and In-House	2
F. ETS Coop Math Test	1
G. Assessment/Placement Services for Community Colleges Test	3

Placement Methods Survey Results - Question 2.

How do you measure the progress of success of students while enrolled in developmental/remedial courses?

		Number of Reports		
		Reading	Writing	Math
A.	Standardized	19	8	6
B.	In-House	2	6	2
C.	Course Exam	9	23	29
D.	Other	4	5	1

APPENDIX B

Students enrolled in programs leading to the AA, AS, AA&S and baccalaureate degrees should at a minimum possess the skills required of students who have taken Algebra I, Geometry, and Algebra II in high school. The following competencies are taken from the Standards of Learning Objectives for Geometry and Algebra II, Virginia State Department of Education, as required for the 22-credit diploma.

1. The student will identify and use the correct notations to a point, line, ray, angle, line segment, and plane when given an appropriate diagram.

   Descriptive Statement: All points on the diagram will be designated by letters. Three-letter notations will be used to name the angles. Angles to be identified will be restricted to those with a measure "m," such that $0 \leq m \leq 180$.

2. The student, given a short verbal argument including a hypothesis and a conclusion, will tell whether the conclusion is valid.

   Descriptive Statement: The reasoning process may be inductive or deductive, and the argument may be mathematical or non-mathematical.

3. The student will identify the hypothesis and the conclusion of a conditional statement and write the converse of the given statement.

   Descriptive Statement: Sentences will be of the following nature: "If a figure is a triangle, then it has three sides".

4. The student, given an appropriate diagram, will identify the following angles: acute, right, obtuse, adjacent, vertical, complementary, and supplementary.

   Descriptive Statement: Three-letter notations will be used to identify the angles.

5. The student will prove two triangles congruent given appropriate information.

   Descriptive Statement: Information given may be in the form of a figure and/or a statement. The type of problem included will require a simple straight forward proof with a limited number of steps. The major theorems and/or postulates used will be: Side, Side, Side; Angle, Side; Angle, Side, Angle; Angle, Angle, Side; and Hypotenuse, Leg.

6. The student will apply the properties for inequalities to the measures of sides and angles in one triangle.

   Descriptive Statement: This will include using proper notation to designate the largest and smallest angles of a triangle when given the linear measurements of the sides of a triangle. Conversely, the student, when given the angular measurements of the angles of a triangle, will designate the shortest and longest sides of that triangle using proper notations.

7. The student, given an appropriate diagram, will identify pairs of angles formed when two parallel lines are cut by a transversal.

   Descriptive Statement: Angle pairs to be identified include: corresponding angles, alternate interior angles, alternate exterior angles, and interior angles on the same side of the transversal.

8. The student will apply certain theorems or postulates about parallel lines in proving lines parallel in non-complicated figures.

   Descriptive Statement: Certain theorems or postulates will include those directly related to angle measures of corresponding angles, interior angles, and alternate interior angles.

9. The student will use the Pythagorean Theorem and/or its converse to solve certain problems about right triangles.

   Descriptive Statement: Certain problems will include finding a missing length of a side in a right triangle when the lengths of the other two sides are given; determining if a triangle is a right when given the lengths of the three sides; and solving real-life problems. Students will not be expected to compute the square root of numbers.

10. The student will determine the lengths of two sides of a 30 - 60 right triangle or a 45 degrees - 45 degrees right triangle when the length of the third side and other necessary information is given.

11. The student will identify certain properties of parallelograms, rectangles, squares, rhombi, and trapezoids.

    Descriptive Statement: The intent of this objective is to emphasize understanding and not necessarily memory of facts. Certain properties will include those which relate to opposite sides, consecutive sides, opposite angles, consecutive angles, and diagonals.

12. The student will find the sum of the measures of the interior angles of regular polygons (ten sides or less) given the number of sides of the polygon.

13. The student will apply the properties of similar polygons to find the measures of sides and angles.

    Descriptive Statement: A diagram of two similar polygons with appropriate measures will be given.

14. The student will find the perimeter of polygons and the area of triangles and parallelograms.

    Descriptive Statement: If a diagram is given, the lengths of all sides will be given. Information may be given in narrative form. Both the U. S. customary and metric units of measurement will be used.

15. The student find the circumference and area of a circle when given the radius or diameter.

    Descriptive Statement: A value for will be given.

16. The student, given an appropriate diagram of a circle, will identify and use the correct notation for naming the following: radius, diameter, tangent, secant, chord, center, minor arc, major arc, semicircle, and central angle.

    Descriptive Statement: All terms are related to a circle.

17. The student will find the total area and volume of a right rectangular prism, right cylinder, sphere, and right cone when given the respective formulas and appropriate information.

    Descriptive Statement: Oblique figures will not be considered. Information given will relate to faces, edges, lateral edges, vertices, altitudes, slant heights, and radii. A value for will be given.

18. The student, using a straightedge and compass, will construct a line segment congruent to a given line segment, the bisector of a line segment, a line perpendicular to a given line, the bisector of a given angle, and an angle congruent to a given angle.

19. The student will determine whether a figure is symmetric with respect to a line.

    Descriptive Statement: The student will be given figures approximately scaled.

20. The student will find the distance between two points in a coordinate plane, given the coordinates of the points.

    Descriptive Statement: If radicals occur in the answer, they should be expressed in simplest form. Students will not be expected to find the square root of a number by means of computation. A table of roots and powers should be provided.

21. The student will solve word problems which require the application of geometry.

    Descriptive Statement: Problems will be limited to the content described in this set of objectives (Geometry).

22. The student will identify the field properties, axioms of equality, and properties of order as related to the system of real numbers and its subsystems.

23. The student will add, subtract, multiply, divide, and simplify polynomials and rational expressions.

    Descriptive Statement: Methods used to factor polynomials will include greatest common monomial factor, difference of squares, perfect square trinomial and general trinomials, factoring by grouping, and sum and difference of cubes.

24. The student will use the laws of exponents to simplify expressions involving rational exponents.

25. The student will add, subtract, multiply, divide, and simplify radical expressions.

    Descriptive Statement: Radical expressions will be rewritten as expressions containing rational exponents, and vice versa.

26. The student will solve linear equations in one variable and solve and graph the solution set of linear inequalities in one variable.

    Descriptive Statement: The replacement set will be the real numbers. Absolute value equations and inequalities will be included.

27. The student will solve quadratic equations in one variable and solve and graph the solution set of quadratic inequalities in one variable.

    Descriptive Statement: Methods for solving equations will include factoring, completing the square, and using the quadratic formula. The replacement set will be the real numbers.

28. The student will solve quadratic equations over the field of complex numbers.

    Descriptive Statement: A comparison of the properties of the complex number system with those of the real number system should be included.

29. The student will solve equations containing rational expressions and equations containing radical expressions.

    Descriptive Statements: Equations with extraneous values will be included. No more than two radical expressions will be included in any of the radical equations.

30. The student will graph relations and functions and will determine their domain and range.

    Descriptive Statement: Functions will be described by a rule, a set of ordered pairs, or a graph. Linear, quadratic, and absolute value functions will be included.

31. The student will find the value of a function for a given element in its domain, locate the zeros of a function, and find the inverse of a linear function.

    Descriptive Statement: Functions should be limited to the second degree.

32. The student will write an equation of a line satisfying given conditions.

    Descriptive Statement: The given condition will include one of the following:

    a) the graph of the line;
    b) two points on the line;
    c) the slope and a point on the line;
    d) a point on the line and an equation of a parallel line; or
    e) a point on the line and an equation of a perpendicular line.

    Equations will be written in the slope-intercept form or standard form.

33. The student will distinguish between equations of the conic sections and sketch their graphs.

    Descriptive Statement: Centers of circles, ellipses and hyperbolas will be at the origin.

34. The students will solve systems of equations and systems of inequalities.

    Descriptive Statement: Systems of equations will include two linear equations in two variables, three linear equations in three variables, one linear equation and one quadratic equation, and two quadratic equations. Methods for solving systems of equations will include graphing for systems of two equations, linear combination and substitution for all systems of equations. Cramer's Rule may be used for systems of two linear equations. Only systems of linear inequalities in two variables will be included.

35. The student will solve polynomial equations and determine linear factors of polynomials.

    Descriptive Statement: The Factor, Remainder, and Rational Root Theorems and synthetic division may be used. Polynomials will be third degree or higher.

36. The student will use algebraic concepts to solve word problems.

    Descriptive Statement: Problem types will include distance problems involving systems of equations, area problems requiring quadratic equations, mixture problems, work problems, maximum and minimum problems relating to quadratic functions, and problems involving direct and inverse variation.

APPENDIX C

Students enrolled in programs leading to the AAS should at a minimum possess the skills required of high-school students who pass the mathematics competency test required for graduation and Introduction to Algebraic Concepts or its equivalent. The following list of competencies draws upon the statewide Minimum Competencies for Mathematics and the Standards of Learning Objectives for Introduction to Algebraic Concepts, Virginia Department of Education.

1. The student will read and write numerals correctly.

   Descriptive Statement: The content will include naming whole numbers less than ten thousand and writing the word name for the number.

2. The student will compare numerical values of whole numbers, given a specific set.

   Descriptive Statement: Whole numbers, named by numerals of not more than four digits, will be included.

3. The student will add, subtract, multiply, and divide whole numbers, 999 or less.

   Descriptive Statement: Addition problems will include no more than four addends and in division problems, the division will include no more than two digits.

4. The student will add, subtract, and multiply decimal fractions.

   Descriptive Statement: Addition and subtraction problems will contain no more than four digits and no more than three places to the right of the decimal point.

5. The student will properly place the decimal point in the quotient of a division problem of decimal fractions.

   Descriptive Statement: Multiplication problems will contain no more than three digits with the decimal point in any position.

6. The student will add, subtract, multiply, and divide simple fractions.

   Descriptive Statement: Each fraction will have a denominator of 15 or less.

7. The student will express a given percent as an equivalent decimal.

8. The student will express a given fraction as an equivalent decimal.

   Fractions will have single digit denominators (?).

9. The student will find a given percent (from 1-100 incensive) of a number.

10. The student will read and interpret data represented in bar, line, and circle graphs.

    Descriptive Statement: The content will include examples similar to those seen in newspapers, consumer publications, and introductory social studies courses.

11. The student will read and interpret tables.

    Descriptive Statement: The content will include federal or state income tax table, sales tax, interest, and insurance premiums.

12. The student will identify objects and/or lines positioned in such a manner that the concept of parallelism is represented, and identify certain parts - center, radius, and diameter - of a circle.

13. The student will read simple picture, bar and line graphs.

14. The student will determine the perimeter and area of rectangular regions.

15. The student will identify units of measure for length, mass (weight), and capacity; read a thermometer; and determine elapsed time. (Maximum 12-hour time interval).

    Descriptive Statement: Intent will include both standard and metric measurements.

16. The student will solve practical problems dealing with everyday situations and requiring the competencies listed above.

17. The students will represent verbal quantitative expressions as algebraic expressions.

    Descriptive Statement: The content will include numerical expressions with and without grouping symbols.

18. The student will evaluate algebraic expressions for a given replacement of the variable.

    Descriptive Statement: No more than one set of grouping symbols and no more than two operational symbols will be used. The context should include problems such as $2n + 1$ when $n = 1$ and also problems such as $7(4 + 8)$.

19. The student will translate verbal sentences into equal, unequal, greater than, or less than numerical sentences.

    Descriptive Statement: Sentences will contain both negative and non-negative integers. (Ex. Five is greater than two -- $5 > 2$).

20. The student will translate, verbal statements of mathematical or scientific relationships to formulas and read formulas as word statements.

Descriptive Statement: (Ex. The area of a rectangle is equal to the product of the length times the width A = -- LW or P = a + b + c -- The perimeter of a triangle is equal to the sum of its three sides)

21. The student will use positive and negative numbers to represent opposites.

    Descriptive Statement: (Ex. The opposite of +3 is -3)

22. The student will factor a composite number completely.

    Descriptive Statement: (Ex. 30 = 2 x 3 x 5)

23. The student will add, subtract, multiply, and divide integers.

    Descriptive Statement: Integers named by numerals between -999 and +999.

24. The student will apply the order of operations to numerical expressions that include parentheses and exponents.

    Descriptive Statement: Statements will contain grouping symbols and exponents (Ex. 3 + 4 - 5 2 +(8 + 9) = 3 + 16 - 10 + 17 = 26)

25. The student will solve specific problems given a formula.

    Descriptive Statement: Formulas will include those for area and perimeter of triangles, squares, rectangles, parallelograms, interest, distance, cost, and lever.

26. The student will add and subtract monomials, binomials, and trinomials.

    Descriptive Statement: The coefficients of the terms will be integers and the degree will be no greater than one (Ex. Add 3A + 4B and 6A + 9B)

27. The student will use the distributive property by multiplying monomials and trinominals in algebraic expressions.

    Descriptive Statement: The coefficients of the terms will be integers and the degree will be no greater than one. (Ex. Multiply 8A + 6B by 7)

28. The student will factor a polynomial by removing the greatest common monomial factor.

    Descriptive Statement: (Ex. Factor 3A + 6B + 9C)

29. The student will solve linear equations using addition, subtraction, multiplication and/or division.

    Descriptive Statement: The coefficients of the variable terms will be integers.

30. The student will substitute numbers in formulas and solve for a specified unknown quantity.

    Descriptive Statement: (Ex. In the formula $d = rt$ if $d = 60$ miles and $t = 4$ hours, find r)

31. The student will solve simple proportions with one unknown.

    Descriptive Statement: (Ex. if $a : b = c : d$ and $b = 2$, $c = 6$ and $d = 4$, find a)

32. The student will use algebraic methods to solve simple problems related to everyday life.

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